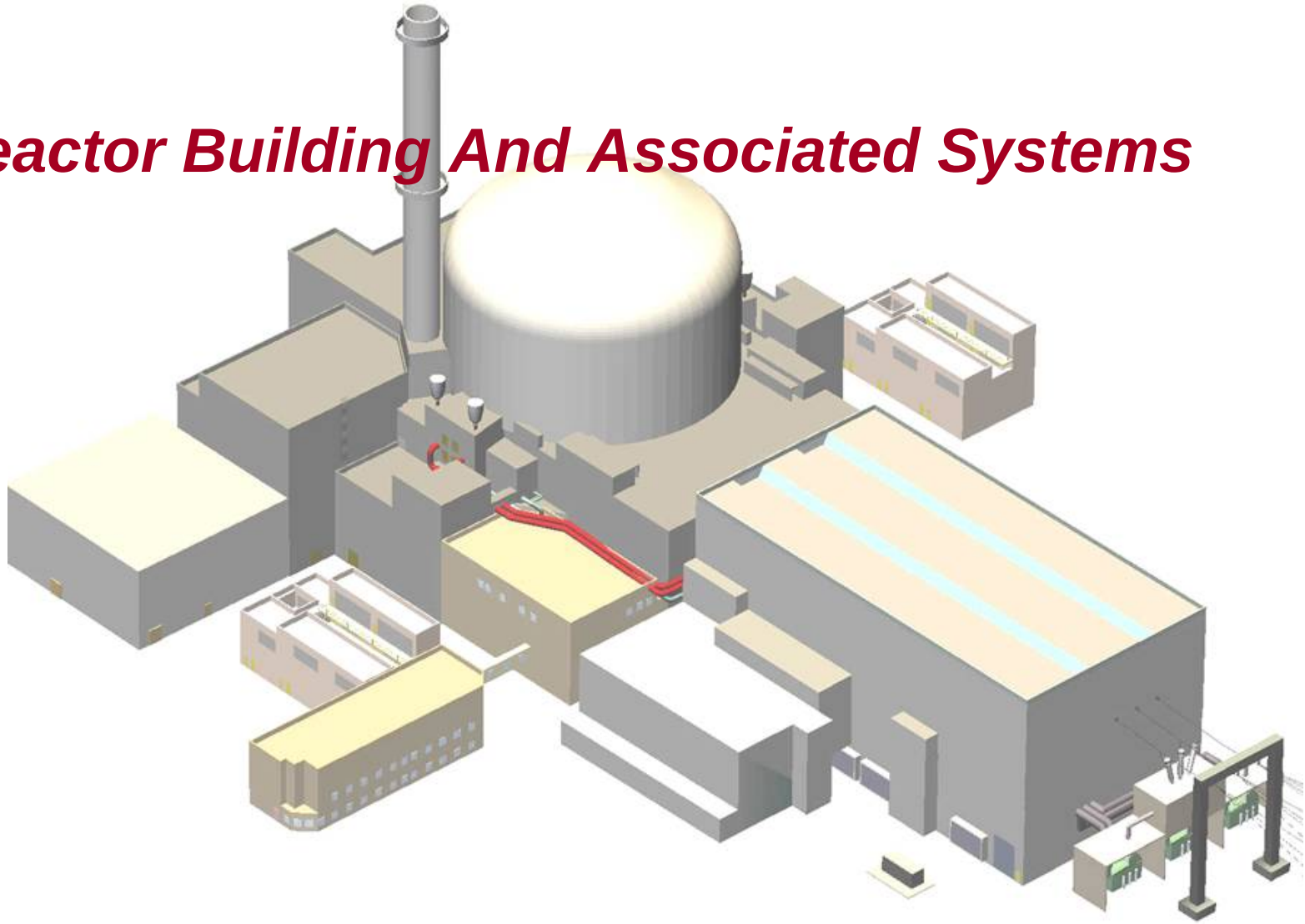
Reactor Building And Associated Systems



Tim Stack
Technical Integration
AREVA NP, Inc.

Demands on Reactor Building

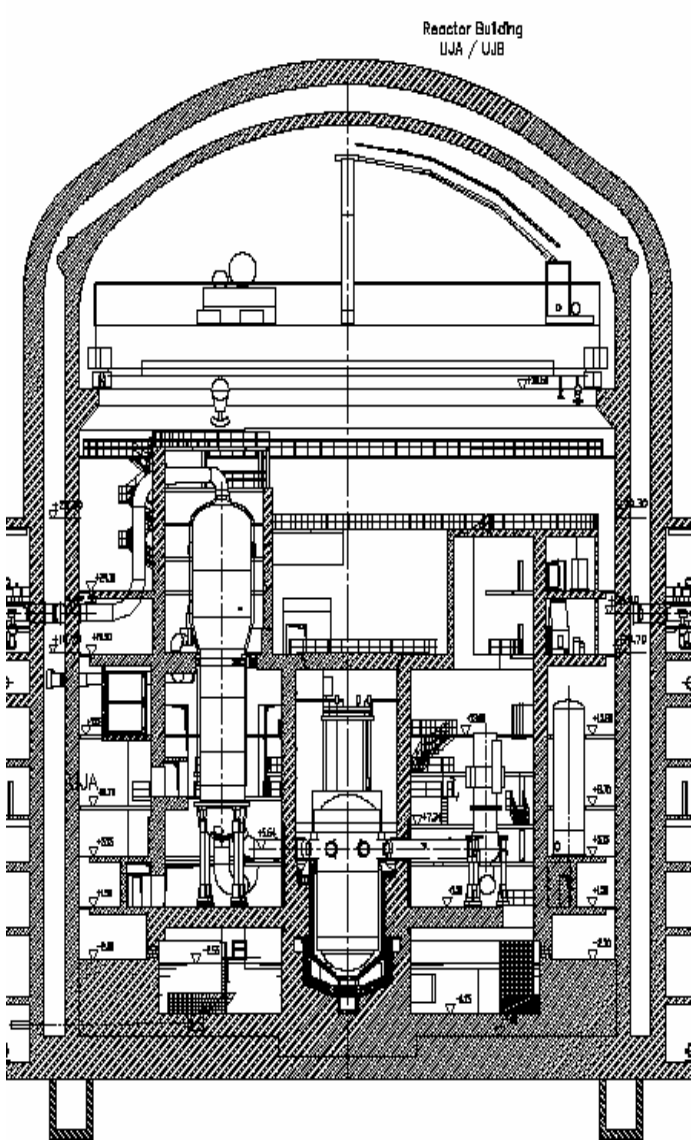
- High Energy Pipe Ruptures (LOCA, MSLB)
- Failure of vessels and tanks
- Aircraft Hazards
- Load Drops
- Internal Explosion and Missiles
- Fire
- Flooding
- Seismic
- Explosion Pressure Wave

EPR Reactor Building Systems

- Containment Building
- Shield Building
- Annulus Ventilation System
- Non-Safety Related Containment Ventilation
- Penetrations, Hatches, Airlocks
- Containment Isolation
- Severe Accident Mitigation Design Features (e.g., Basemat Cooling)

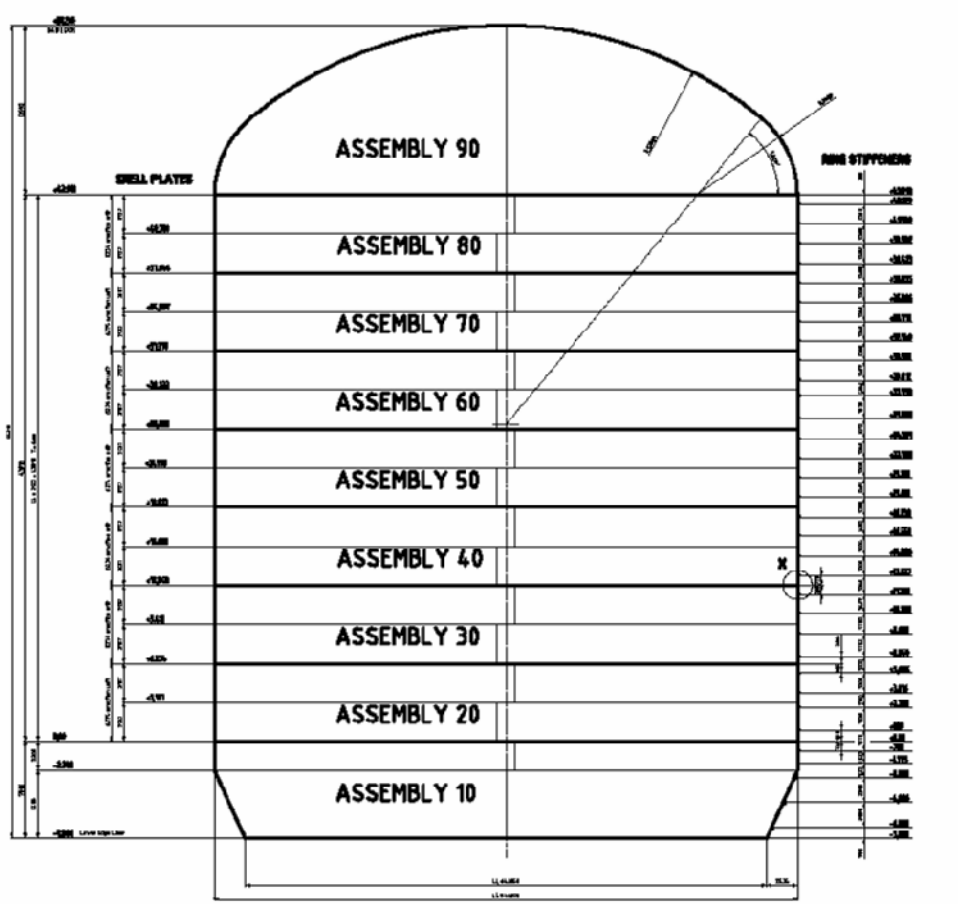
EPR Reactor Building

- Containment wall post-tensioned concrete with steel liner
- Shield Bldg wall reinforced concrete
- Containment Free Volume = 2.8 Mft^3
- Containment Inside Diameter = 153.5 ft.
- Containment Wall Thickness = 4.3 ft.
- Design pressure = 62 psig
- Design temperature = 338 °F
- Annulus sub-atmospheric and filtered to reduce radioisotope release
- In-Containment Refueling Water Storage Tank (~500,000 gal)
- Severe accident mitigation features
- Design leak-rate at design pressure for a 24-hour period is less than 0.25 percent by volume



Containment Liner Plate

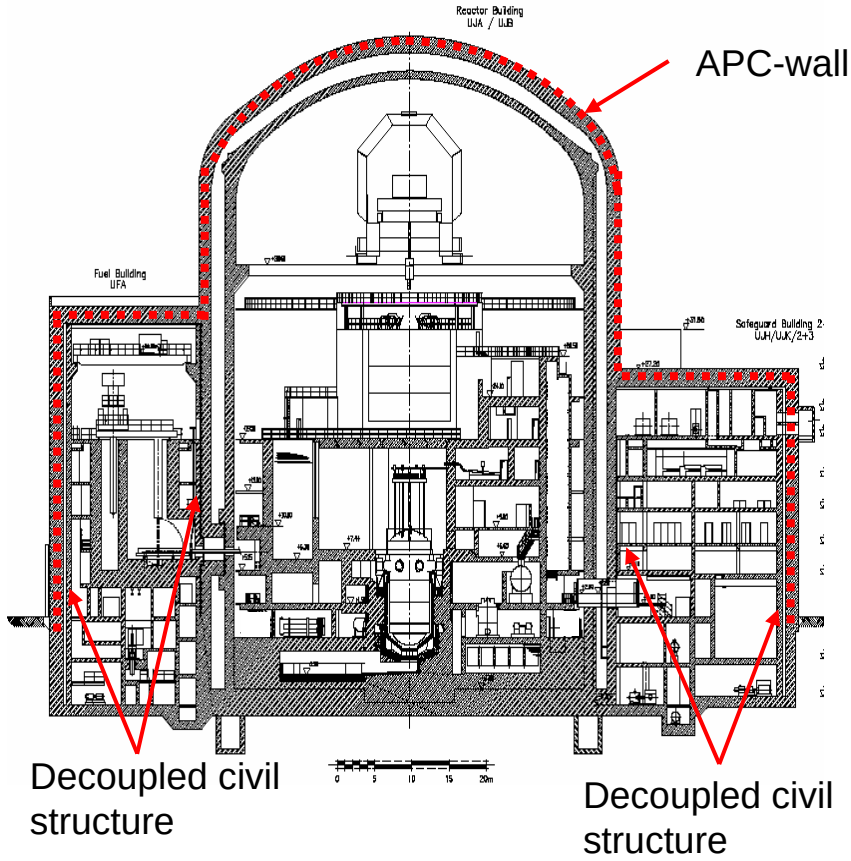
- Liner thickness = ¼”
- Carbon steel liner with no stress relief required
- Liner extends into basemat to prevent release of radioactivity into ground



Containment Liner Plate

Shield Building

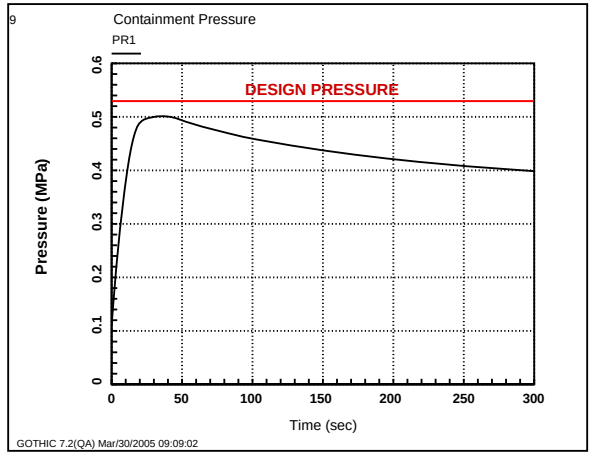
- **Primary Function – Protect Containment Building from external hazards**
  - **Reinforced Concrete (without liner)**
  - **Inside Diameter 53 m (174 ft.)**
  - **Isolated from Containment down to basemat**
  - **1.8 m (5’ 10”) thick above adjacent Safeguards Building roofs**
  - **1.3 m (4’ 3”) thick below adjacent Safeguards Building roofs**



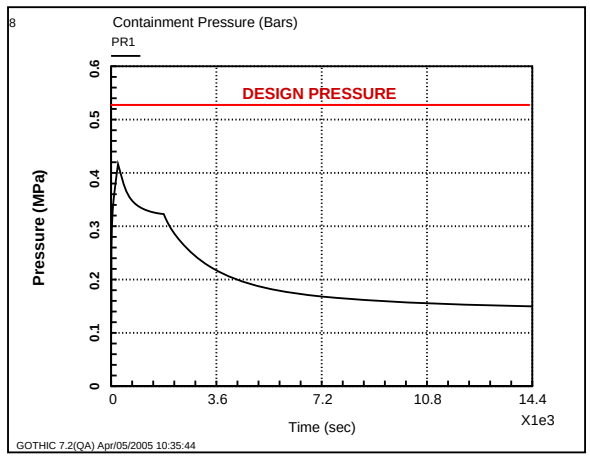
Containment P/T Response to DBA

- Containment sprays and fan coolers not required to mitigate short-term pressure or temperature responses to DBAs
- Containment sprays and fan coolers not required to mitigate long-term pressure response to DBAs
  - RHR system sufficient to reduce pressure to ½ the peak in < 8 hrs after LOCA

LOCA

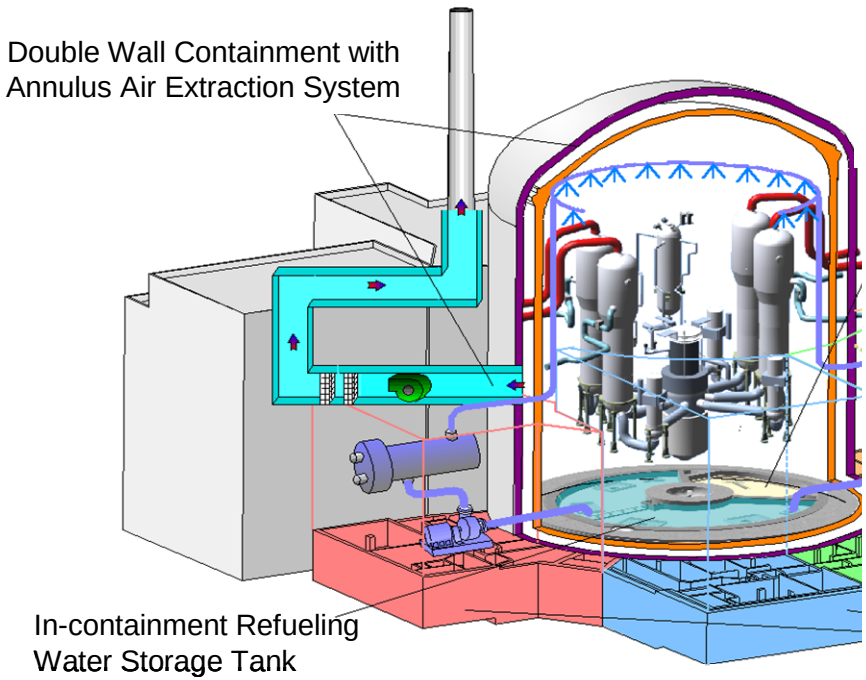


SLB



Radiological Consequences to DBA

- **Containment sprays <u>not</u> required for Iodine removal following design basis accident:**
  - **Annulus Ventilation System**
    - **Maintains annulus at least 620 Pa (0.09 psi) sub-atmospheric**
    - **Two safety-related, 100% capacity air extraction systems powered from separate Safeguards divisions**
    - **Exhaust all annulus air through HEPA and Iodine filters prior to release**
  - **Limit containment building leakage to 0.25% volume/day at design pressure**



Containment Isolation

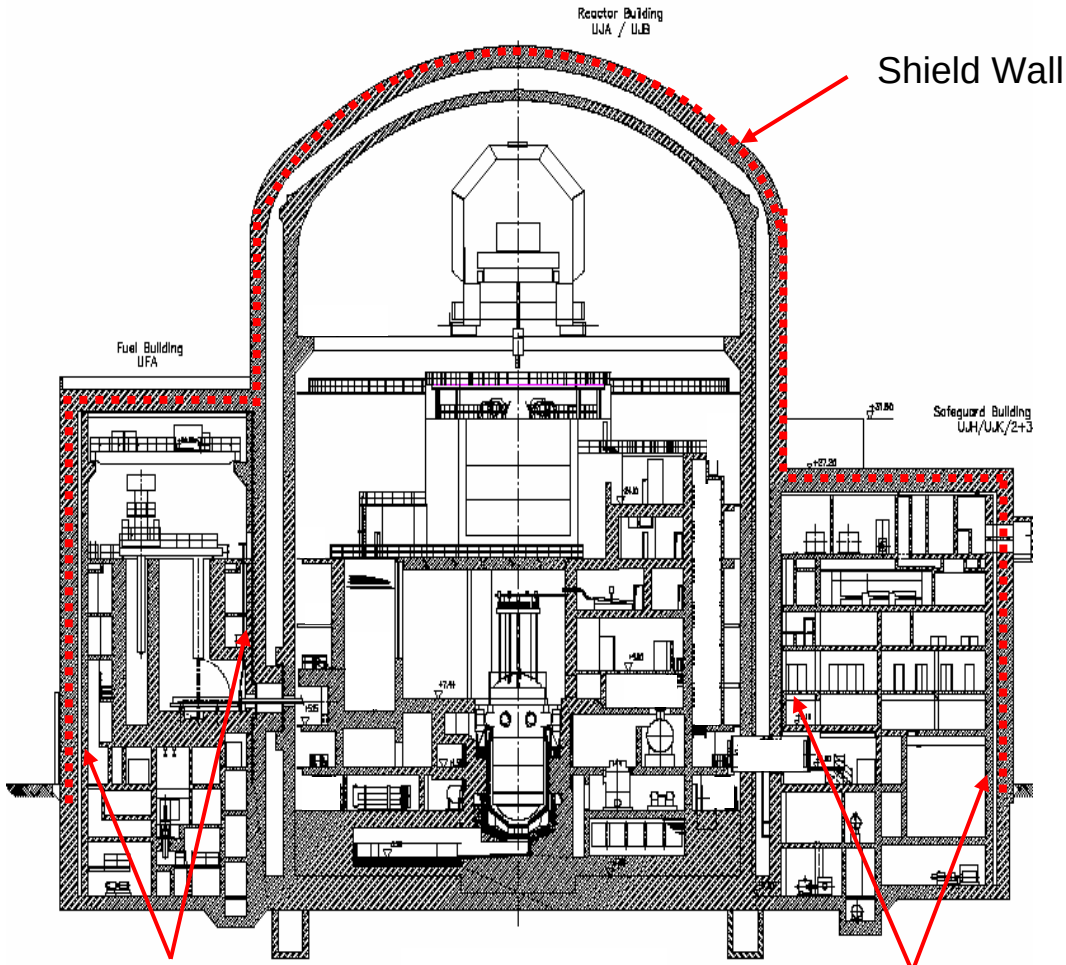
- **Function is containment isolation to minimize release of fission products to environment.**

- **EPR Containment isolation provisions:**
  - **Assured through penetration and isolation valve arrangements needed to isolate containment.**
  - **Generally include minimum of 2 isolation valves powered and operated independently. Valves are automatically isolated or locked closed.**
  - **Satisfy NRC criteria for containment isolation.**

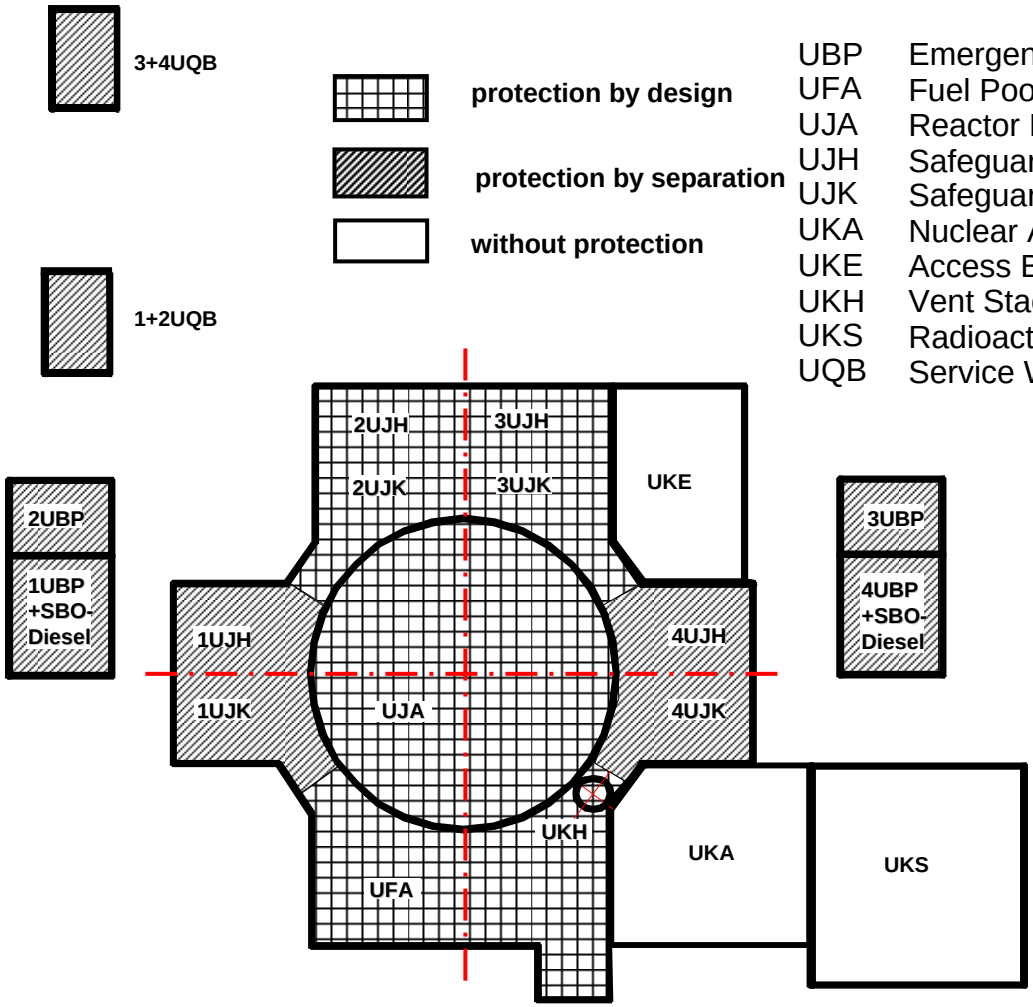
Aircraft Hazard Protection

- Penetration (local resistance)
- Overturning (global stability)
- Secondary Missiles (spalling)
- Induced Vibrations
- Fire (fuel)

Aircraft Hazard Protection

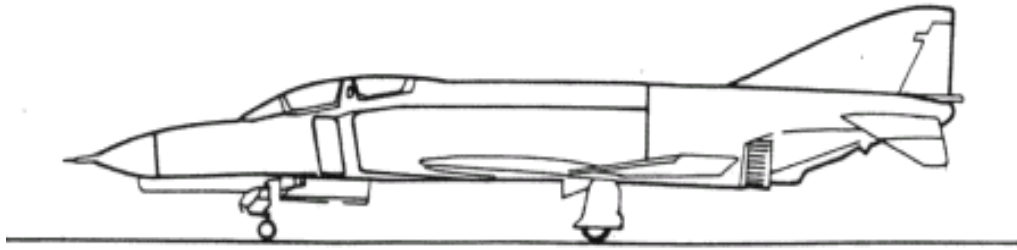


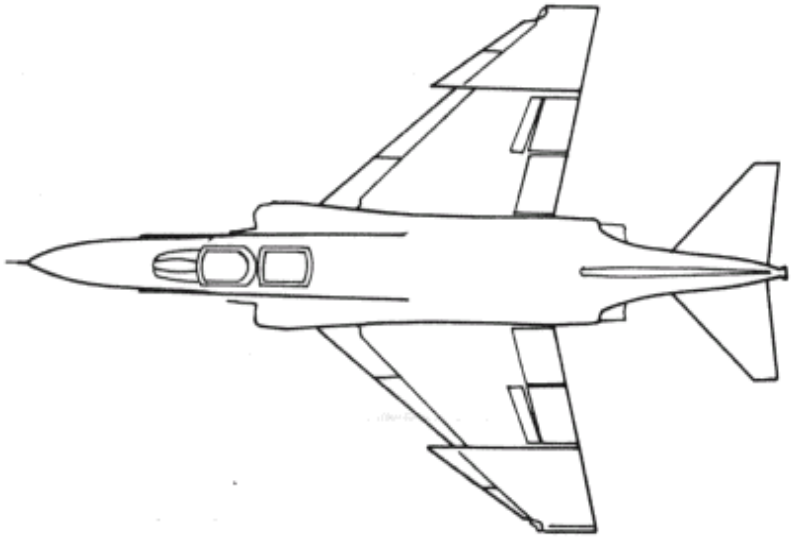
Aircraft Hazard Protection

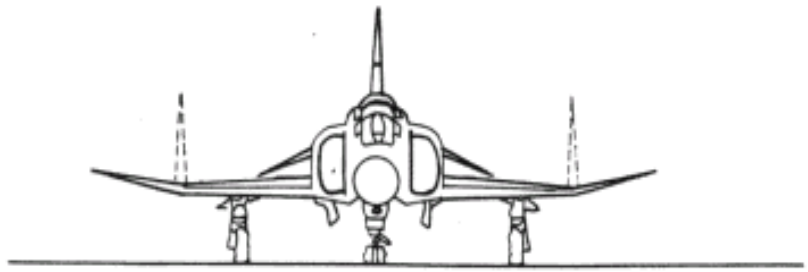


UBP	Emergency Diesel Generator Building
UFA	Fuel Pool Building
UJA	Reactor Building
UJH	Safeguard Building, Mechanical Part
UJK	Safeguard Building, Electrical Part
UKA	Nuclear Auxiliary Building
UKE	Access Building
UKH	Vent Stack
UKS	Radioactive Waste Processing Building
UQB	Service Water Pump Building

Aircraft Hazard Protection

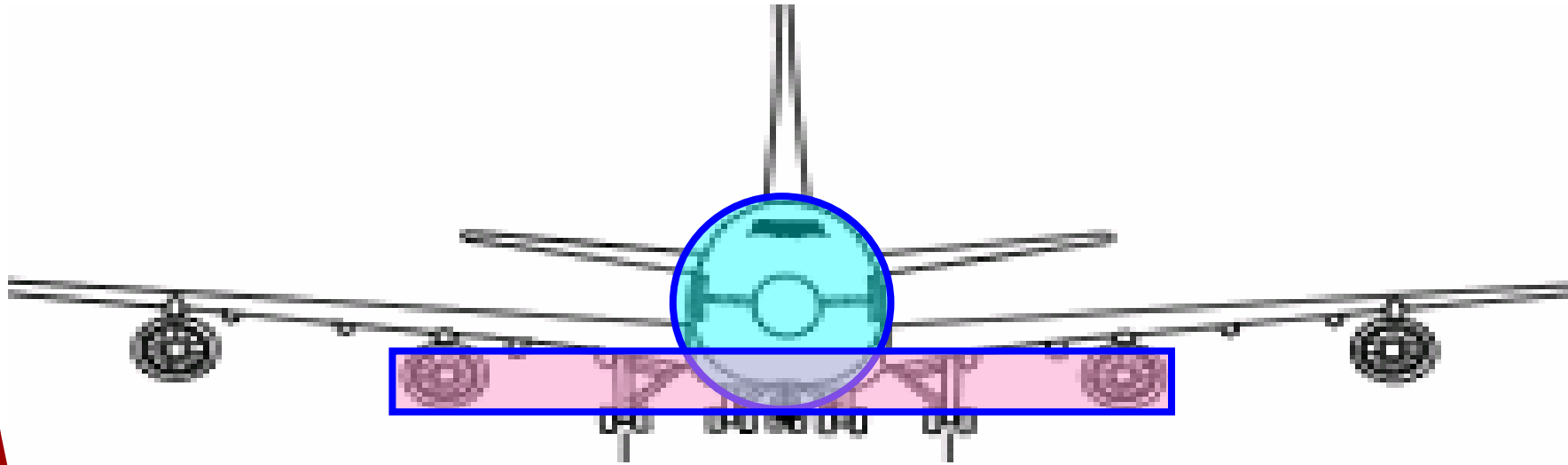






Aircraft Hazard Protection

Commercial Aircraft Loaded Areas



Summary – Reactor Building System

- **EPR Reactor Building System consists of:**
  - **Post-tensioned concrete containment building with steel liner**
  - **Reinforced concrete shield building that surrounds containment building**
  - **Annulus ventilation system**
  - **Containment isolation system**
  - **Design features to mitigate severe accident scenarios**
- **Mitigate containment pressure/temperature response to DBAs without safety-related sprays or fan coolers.**
- **Mitigate radiological consequences to DBAs without safety-related sprays.**
- **Protect against spectrum of aircraft hazards and external explosions.**